Run 7 – Heavy Ions Summary

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Run 7 Strategies

- As much routine as possible (QGP factory)
  - avoid major and costly changes/upgrades:
    - no booster bunch merge
    - avoid risk of man-power shortage (cooling)
    - no IBS suppression lattice
  - only small changes at the time
    - stochastic cooling (we will have anyway)
    - some improvement on β* (0.8 m?)
      - backgrounds?
    - slowly increase no. of bunches (limit < 111?)
    - automation (software), reduce time between stores
    - reduced set-up time due to tune-feedback and decoupling on the ramp
    - touch machine as little as possible
    - go into production mode as early as possible
    - focus on reliability

- as aggressive as possible
  - get major upgrades out of the way:
    - booster bunch merge (requires HW changes and development time > 2 weeks)
    - develop alternative to debunch-rebunch in the AGS (untested!)
      - gap cleaning?
      - polarization development?
      - emittance?
      - transition crossing/pressure
    - focus on intensity (vs. cooling)
  - develop IBS suppression lattice
    - start-up with a ramp that's still undeveloped
    - unknown outcome (lost time if doesn't work)
  - production mode will start later, time between stores could be longer
    - machine might be 'touchier' (unknown lattice) => more lost ramps, less reliability
    - cooling (low mom. spread) could cause yellow to be more delicate => chromaticity control in yellow more important (also applies to routine strategy)

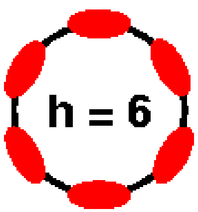
Issues discussed in 'overview'

- determine optimal store length (STAR: longer than 4 h, PHENIX: shorter than 4 h)
  - who should define/decide the optimal length?
- when should development after ramp-up be done? days vs. evenings/nights
- why did the automation task not get finished and implemented before run 6?
  - implementation of automatic orbit correction
  - can it happen this time?
- could the optimal refill-time be determined (in a 'formal' way)?
- what caused us to deviate from this optimal time? (list of failure, failure times, etc.)
- we have to decide now about what lattice and which strategy to use!
  - meet this week (tomorrow?). who should be involved?

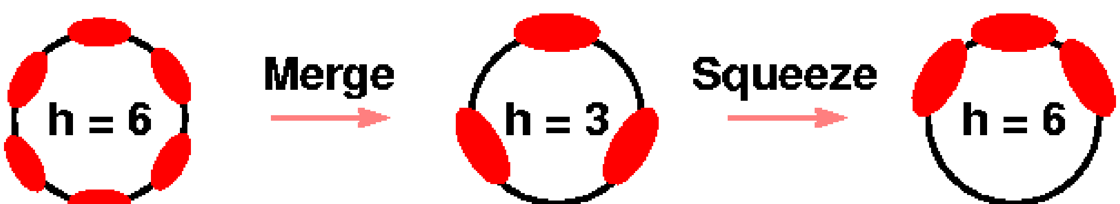
Injectors

- what's the potential for a conflict between mode-switching and NSRL running?
- in case of d-Au: mode switching needs to be exercised in a dry-run (hasn't been done in 4 years)
  - switching is 3-5 minutes
- tandem is very reliable

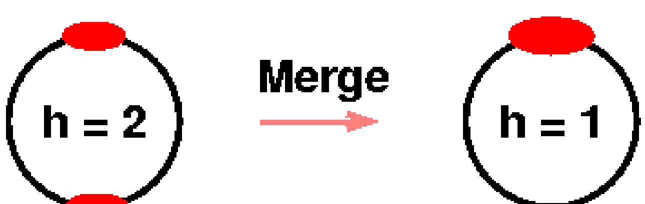
Booster Acceleration/Bunch merge



Standard gold setup
0.93 to 101 MeV per nucleon



Brennan's new gold setup; doubles the intensity per bunch



Standard deuteron setup
8.7 to 506 MeV per nucleon

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AGS bunch merge 24 ⇢ 4

- replace rebunch-debunch
  - avoid debunching
    - no baby bunches
    - low dp/p instability avoided
    - less tweaking
  - 2 days, 3 shifts with beam
  - could be made standard operation even w/o booster bunch merge

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RF improvements

- 24 to 4 AGS bunch merge: **must do**
- reduce AtR shot-2-shot jitter (1 ns)
  - needs high frequency phase detection
  - improve AtR synchro: 1 man week (standard: 1 shift)
  - **should do**

- booster bunch merge:
  - low level RF was implemented by 'bricolage' (not in the control system)
  - would need to dust off HW and home brew SW
  - requested man-power & time: 2 weeks min.
  - never transferred more than 7 cycles into AGS ("forbidden" by magnet cycle, solution exists?)
  - recommendation: **don't do** it for run 7

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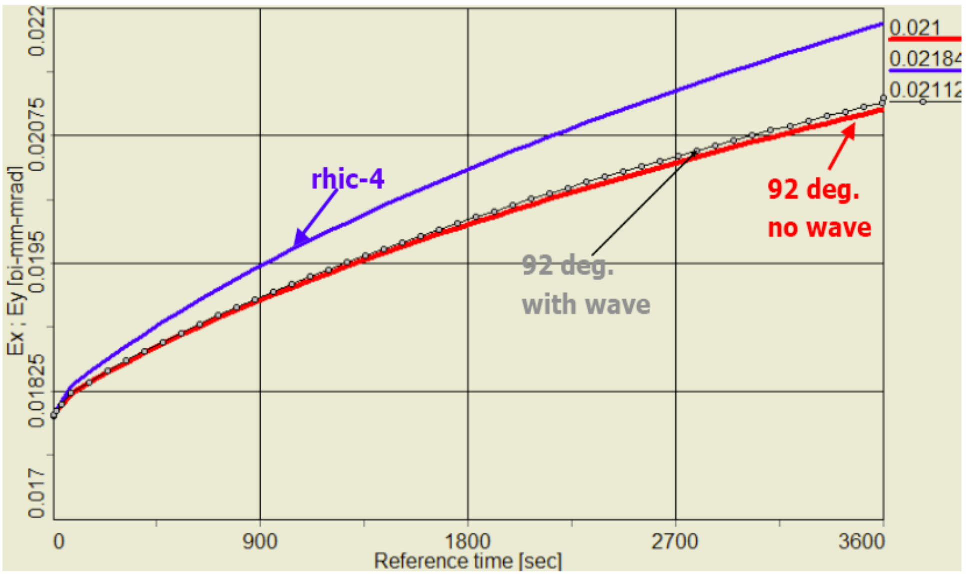
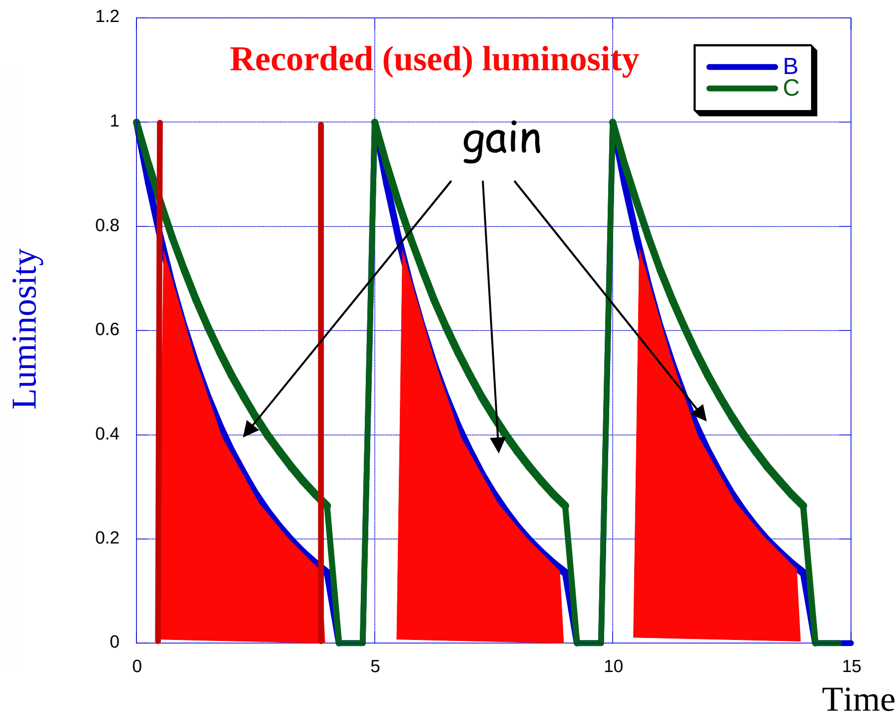
IBS suppression lattice





- predicted emittance growth with and w/o IBS suppression
- model calculations can be trusted (well calibrated w. exp. data!)

- assume 0.5 h at the beginning and 1 h between stores
- gain int. Lumi of about 25-30% predicted

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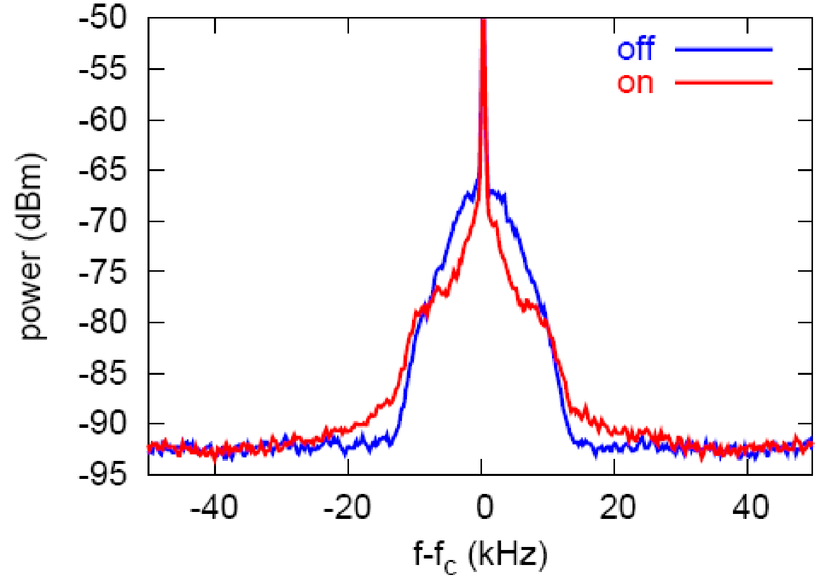
IBS suppression lattice

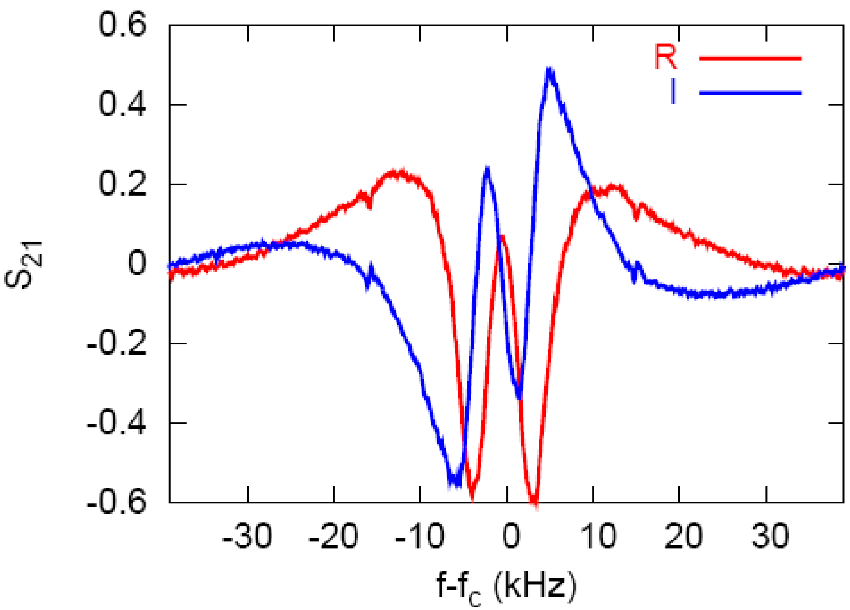
- main contribution to <u>transverse IBS</u> is from the arc FODO cells
- raise the tune (+1 in both planes), increase cell phase advance
- limitations
  - sextupole strength, affect of phase advance on SD sextupole?
  - power supplies, shunt PS cabling scheme
  - γ_t moves
  - matching
  - dynamic aperture
- test lattice w. 92 deg. phase advance , already existing
  - 37% IBS reduction
  - ramps developed for diff. energies: 100, 85, 31 GeV
  - blue beam had 83% transmission to 31 GeV (crossed transition!)
- assume 2 h lifetime, between 0.5-1 h between fills, this lattice could enhance luminosity by about 25%
- does the new phase advance affect other systems?
- when should we stop the development and declare it failed?
- ramp development for Au@100 GeV
  - would be approx. 1-2 weeks (Steve Tepikian)
  - dyn. apperture simulation desirable (Yun)
  - preparation of IBS suppression lattice likely to interfere with pp luminosity effort

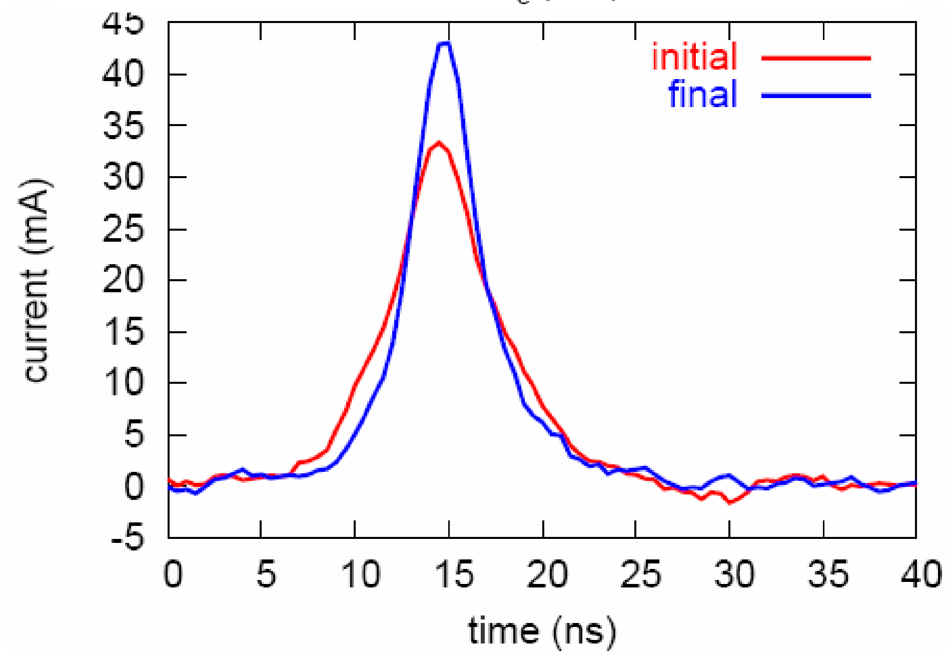
stochastic cooling

micro-bunch (1 10^9)

Signal suppression and
BTF at 5.2 GHz.
14 of 16 cavities operating.
Cooling achieved!







Stochastic Cooling

- Coherent signals are understood and can be dealt with.
- Cooling using narrow band cavities works.
- RF voltage is constrained by the cooling system in yellow, blue should have no problems.
- Automatic adjustment of cooling parameters has been checked piecewise.
- Full automation looks straightforward.
- Stochastic cooling has been demonstrated.
  - we expect visible improvement from cooling in yellow towards the end of the run 7 Au operation

Operational scenario for cooling

- <u>Precooling yellow</u>
  - Is precooling needed? Rebucket if no.
  - Check orbits, fix if needed. Close kickers and pickup (sequencer)
  - Measure delay filters and correct (FEC to subordinates)
  - Measure BTFs. Adjust cavity gains and phases. (same as above)
  - Cool
  - Periodically adjust delay, gains and phases (set interval on FEC)
  - Cool
  - If rebucketing not done, execute when emittance is small enough
- For blue a fast feedback loop will adjust delay due to wind and other sources of vibration.
- pre-cooling would take approx. 20 min.
  - if experiments don't take data during pre-cooling this affects recordable luminosity

Vacuum

- IR10 layout
  - 2005: 8.5 m NEG coat added (removed Be pipe) => 10^{-11} Torr
- cold bore
  - pre-2005: no active pumping during warm-up
  - 2005 shutdown: pump down before cooling starts installed TMPs (fixed and portable)
  - 4 Ion Pump/arc, 1 ion pump/triplet,
  - pump down to 10-9 Torr before cool down
  - no more pumps this year planned
- NEG
  - added 45 m in 2006 , totals 463 m now
  - add coated BBLR chambers in bi5 and yo5
  - 80% NEG coating installed
- some warm bore areas expected in the low e-8 to low e-7 range
- some cold bore areas (end of arc) low e-8, others stayed < e-9
  - no significant pressure increases at present intensities

- expect dynamic pressure rise from EC manageable for Au operation
- EC during transition crossing could limit intensity

transition crossing

- chromaticity has to change sign around transition
  - chrom=0 at transition can cause instability
  - change sign (+ octupoles) just before transition to avoid instability
  - transition jump changes chrom by +2 units ('naturally')
- we always start with a +4 unit jump (-2 to +2), ok with low intensities
  - typical setpoint changes end up around +8
  - meas. chrom vs. set chrom at store indicate a slope of 0.5 (instead of 1)
- should we start with a +8 unit jump to begin with?
  - keep increment constant
  - decoupling at transition important (skew chromaticity could be zero!)
  - change start value to adjust timing of zero-crossing

Conclusion

- we are confident to
  - repeat run4 parameters with more bunches
    - vaccuum upgrades
- possible improvements beyond this are
  - more beta squeeze
  - improved vertex (RF changes in injectors)
    - booster bunch merge: discouraged by expert
  - stochastic cooling in yellow
  - improved set-up time
  - IBS suppression lattice
    - still needs to be discussed more
- if development time is kept at a minimum run 7 could demonstrate 60% time at store